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(19) (CA) APPLICATION FOR CANADIAN PATENT (12)

(54) Subsurface Signal Transmitting Apparatus

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ABSTRACT

A subsurface signal transmitting apparatus including an insulation coupling, a carrier device for mounting the telemetry instrumentation, and a by-pass system for avoiding pressure build-up either above or below the apparatus. The insulation coupling includes a housing member having a central opening defined by an interior surface extending in the longitudinal direction and a mandrel member having an exterior surface spaced from the interior surface of the housing member to provide a gap or clearance with an insulating bonding material occupying the clearance. The surfaces are oriented so that when the coupling is in tension at least a portion of the two surfaces experience interacting forces towards each other in the longitudinal direction of the coupling and in event of failure of the bonding material, the mandrel member is unable to withdraw from the housing member.

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This invention relates to a subsurface signal transmitting apparatus of the type for sensing certain conditions in a bore hole and then transferring them to a surface located receiver.

5 In the oil industry, it is necessary to obtain and analyze down-hole conditions, such as pressures and temperatures at various elevations. This has been done most commonly in the past by lowering electrically or mechanically operated gauge devices into the well, these
10 gauges being either suspended on a wire line or fastened to available oil well tubular sections. By utilizing conductor wire lines, the information can be transmitted to the surface on a "real-time" bases. When non-conductor lines are employed, the gauge must be withdrawn to the
15 surface so that the data can be either down-loaded to a plotter or read directly from an internally scribed chart, thus providing the operator with the desired information. In this process, whether the wire line is used as a suspension member or is strapped to the outside of tubulars
20 forming a string in the bore hole, damaging of the wire line is not uncommon. The damage or destruction of the wire line can occur when the string sticks within the bore hole, or when the wire line and/or tubing string is being run in or out of the hole. Not only is there the cost of
25 the lost equipment, but such damage adds significantly to the cost of the operation, of course, because of the time

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involved in repairing the equipment and in fishing the equipment from the hole. The process of having to fish also includes the risk of endangering the well itself.

Other techniques have been developed for transmitting
5 signals which are produced by apparatus located down-hole to the surface, including devices which develop and transmit signals electromagnetically to the surface. Such signals having been received by a receiving apparatus provide instantaneously information on the conditions
10 sensed down-hole. This telemetry technique involves locating down-hole relatively complex equipment and providing a source of power. Structures have been developed for containing such equipment power source and which enable the use of a portion of the tubing to function
15 as an antenna in the transmission of the signals to the surface. The process of using the tubing string, such as the upper portion of the string, as the antenna involves the provision of a connection which electrically isolates the upper portion from a lower portion of the tubing string
20 so that the output voltage of the down-hole electromagnetic transmitters can be connected across terminals which are electrically isolated from each other.

The approach of using a telemetry technique for transmitting the information to the surface provides
25 instantaneous readings at a set location of the down-hole sensing equipment and also avoids the use of a wire line. While having significant advantages over other techniques,

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problems due to the conditions which exist in the bore hole have hindered successful development in this process. For example, although there exists insulation couplers for use in an arrangement where the upper portion of the tubing is
5 used as an antenna, such coupling have not always functioned satisfactory when the lower portion of the string becomes jammed in the bore hole. This is not uncommon particularly where the lower part of the bore hole deviates from the vertical. Present insulation couplers
10 have not been known to withstand the application of a high torque used in attempting to force the string when jammed, and a severing of the tubing string at the insulation connector results in the lower portion, which houses the expensive telemetry sensing and telemetry equipment,
15 becoming completely disconnected at its down-hole position. Not only is the cost of the equipment involved, but there is the expense involved in reopening the hole and potential damage to the well.

Moreover, due to the nature of the sensing, power
20 source and transmitting equipment utilized in the telemetry process and the extreme conditions to which the down-hole end of the tubing string is subjected, known methods of mounting such equipment has not always proved satisfactory. While the equipment must be protected, the manner in which
25 it is carried and its connection to the insulation connector must be such that it is readily available for exchanging and servicing.

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Yet another characteristic of some known structures is that they are not capable of coping with particular conditions which can develop either above or below the test equipment when located down-hole. The down-hole test equipment is frequently used in conjunction with annular sealing packers, and in the known structures the insulation connector and/or the test equipment and mounting elements, together with the sealing packers in effect form a complete seal or blockage in the bore hole. Accordingly, in the event a pressure build-up develops either above or below the sealing packers, the tubing string can be sucked into or blown out of the bore hole. This can happen with sufficient force to cause severe injury to personnel and damage to equipment.

15 It is an object of the present invention to provide an apparatus for subsurface telemetry signal transmission which overcomes the above described disadvantage of known devices presently available in this technology.

According to one aspect of the present invention, there is provided a connector assembly for connection in a tubing string in a bore hole, the connector assembly electrically insulating an upper section of the string above the connector assembly from a lower section below the connector assembly. The assembly includes an outer housing member and an inner mandrel member. The housing member has connection means adjacent one end of the connector assembly for attachment of the one end to one of the above mentioned

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sections of the string, and the housing member has an internal surface portion defining an opening tapering outwardly in cross sectional area toward that end of the connector assembly. The mandrel member has connection
5 means adjacent the other end of said connector assembly for attachment of that end of the connector assembly to the other of the above mentioned sections of the tubular string, and the mandrel member has an exterior surface portion tapering outwardly in cross sectional area away from that
10 end of said connector assembly. The exterior surface portion of the mandrel member is disposed within the interior surface portion of the housing member and provides a clearance between said surface portions. The connector assembly further includes an electrically non-conducting
15 binder material disposed within the clearance.

It is apparent that in the use of such an insulation connector, the outer housing, which may be connected to the upper portion of the tubular string, can function as an antenna for transmitting signals received from equipment
20 mounted in a carrier section connected to the mandrel member. In the case of a tension force being applied to the connector assembly, shear forces are developed in the binding located in the clearance, but the binding is in compression between the two tapered surface portions of the
25 housing and mandrel members. Moreover, because of the direction of taper relative to the connection means at the opposite ends of the connection assembly, the mandrel

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retrieved from the channels on which they are protected from damage by engagement of the carrier with the sides of the bore hole. The cable which carries the signals to be transmitted can then be located in the provided passage and
5 connected to the antenna providing member of the connection assembly.

According to yet another aspect of the invention there is provided a subsurface signal transmitting apparatus for connection into a tubing string in a bore hole, which
10 apparatus includes an insulation connector assembly and an instrument carrier device. The connector assembly includes an outer housing member and an inner mandrel member, the housing member having a first connector means adjacent one end of the connector assembly for attachment to an adjacent
15 tubular section of the string above the connector assembly. The inner mandrel member has a second connection means for attachment to an upper end of said carrier device, the mandrel member being of tubular form defining a central passageway extending from said one end to said other end of
20 said connector assembly. Means is provided for electrically insulating the housing member from the mandrel member. The carrier device includes an elongated tubular member having channels in the exterior surface thereof for accommodating instrument sensing units. The tubular member
25 also has an internal passageway disposed therein and placing a lower end thereof in communicating with said passageway in said mandrel member at the upper end thereof.

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member cannot be pulled through the housing member due to an excessive tensional pull on the tubular string. Even on failure of the binding in the clearance, the tensional pull results only in the surface portions moving towards an
5 engaging position.

According to another aspect of the invention, there is provided a carrier device for use in a subsurface signal transmitting apparatus the carrier device being in the form of an elongated body member having a generally cylindrical
10 outer surface. A first connection means is located at one end of said body member for attachment of the body member to an insulation connector assembly having an outer housing member electrically insulated from the body member. The body member has defined in the outer surface thereof a
15 plurality of longitudinal channels commencing adjacent the one end and extending towards an opposite end of said body member. Means are provided for detachably securing instrument sensing units individually within the channels, and a passage extends from said channels to the one end of
20 the body and accommodates a signal transmitting cable extending from the units for electrical attachment to the outer housing of said insulation connector assembly.

The carrier device is capable of being attached to an end of the connection assembly, such as that described
25 above, and more particularly to the connection means provided by the mandrel, and sensing units which include a transmitting component can be readily inserted and

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The tubular member has a third connection means at a lower end thereof for attachment of the carrier device to an adjacent section of the tubing string below said carrier device. An electrically insulating by-pass tube extends
5 through the passageways of said mandrel and said carrier device and has fourth and fifth connector means at upper and lower ends thereof, respectively, for connection of the by-pass tube to the sections above and below the apparatus, thus permitting fluid passage through said apparatus.

10 In this structure, the by-pass tube extending through the passageways in both the connector assembly and the carrier device provides for fluid communication past the subsurface transmitting apparatus so that pressure build-up either above or below the apparatus is prevented, and
15 accordingly the destructive results which can result from such build-up is avoided.

In the accompanying drawings which show an embodiment of the invention, as example,

Figures 1A, 1B, 1C, 1D, 1E and 1F, when viewed in
20 combination, show a side cross-section view of the subsurface transmitting apparatus of the present invention, and

Figure 2 is a perspective, exploded view of the carrier device forming part of the apparatus of Figure 1.

25 Referring now to Figure 1, wherein like reference numbers denote like elements described herein, the reference number 10 denotes the overall subsurface transmitting

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apparatus in which the present invention is incorporated.
In Figure 1B and 1C, there is shown an insulation coupler
11 and in Figures 1C to 1F there is shown a carrier device
12 of a preferred embodiment of invention. In use the
5 apparatus 10 is connected at its upper end to a lower end
of tubing string (not shown) which is lowered into the bore
hole for taking readings of conditions in the bore hole,
such as pressure, temperature, relative angle, etc. The
readings are transmitted to a receiver at the surface near
10 the top of the bore for recording and analysis by the
operator. The apparatus may also be used to compute other
information in relation to the equipment status, i.e. the
status of various down-hole components, such as valves,
safety joints, etc. The tubular string includes other
15 sections which are connected to the lower end of the
apparatus 10, and these may include, for example, sealing
packers.

The insulation coupler 12 is in the form of a
connector assembly having an outer housing member 13 and
20 inner mandrel member 14, both of which are formed of metal.
The outer housing member 13 has an outer cylindrical
surface 15 which is preferably of the same diameter of the
other sections in the tubular string, and it is hollow so
as to provide a bore or opening 16 extending therethrough.
25 The opening 16 is of maximum cross-section at its upper end
where there is provided a connection means in the form of
internal threads 17 for attachment of the outer housing

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member 13 is a tubular section 20, which has an externally threaded lower end portion 21 of reduced diameter.

Below the internally threaded upper end of the outer housing member 14, the bore or opening 16 is defined by internal surface 22 which tapers outwardly from the lower end towards the connection means provided by the internal threads 17. The surface 22 is preferably in the form of a conic frustum and wherein the gradient or degree of taper is slight so that the outward taper in cross-section of this portion of the opening 16 is relatively gradual. Below the tapered portion of the opening 16 is a lower portion 23 of the opening 16 which is of less diameter, of course than the cross-section of the internal threaded portion at the upper end. Substantially along the length of the surface defining the lower portion 23 are a plurality of circumferentially spaced, longitudinally extending grooves 24 which are substantially semi-circular in cross-section. At the very lowermost end of the outer housing section 13, the internal bore or opening 16 is enlarged to provide annular enlarged bore providing a seat 25 for a sleeve 65.

The inner mandrel member 14 is mainly received within the opening 16 of the outer housing member 13. It has a lower or tail portion 26 (Figure 1C), which is of smaller diameter than its upper end, and the lower portion 26 has external threads 27 which provide connection means for attachment to the upper end of the carrier device 12. The

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mandrel ends in an end surface 26. The mandrel member 14 is of tubular form and has an opening or bore 30 extending longitudinally therethrough. The bore 30 is of uniform diameter except for a seal receiving enlargement 31 at its upper end. The upper end portion of the mandrel member 14 has an outer surface 32 which tapers outwardly in a direction away from the connector means provided by the threaded lower portion 26. The size of the tapered portion of the mandrel is selected to substantially fill the tapered portion of the opening 16, and the taper is such to match that of the tapered openings, i.e. the gradient or degree of the outer surface 32 which is also a conic frustum is substantially the same as that of the surface 22. When mounted in an assembled condition within the outer housing member a slight gap or clearance 33 remains between surfaces 22 and 32. The thickness of the clearance 33 is substantially constant and is in the order of .040 inch. Although the degree of taper of the surfaces 22 and 32 is not great, the cross-section area of the mandrel adjacent the upper end of the taper is significantly greater than the cross-sectional area of the opening 16 adjacent the lower end of its taper.

Below the tapered surface 32, the mandrel member 14 has a cylindrical portion 34 which has circumferentially spaced, longitudinally extending grooves 35, which are also of substantially semi-circular shape in cross-section. The grooves 24 of the housing member and grooves 32 of the mandrel member align to form a plurality of longitudinal

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openings, which are substantially circular in cross-section, and are located in each of the longitudinal openings as a pin or rod 36, also of circular cross-section and of a diameter to fill the longitudinal opening provided by grooves 24 and 35. The rods are formed of an electrically insulating material, such as a tough plastic material which has a significant shear strength.

The tubular section 20 which is connected to the upper end of the outer housing member 12 is a substitute connector in that its upper end has an internally threaded tapered bore 37 (Figures 1A and 1B) for receiving an externally threaded lower end portion 40 of a tubular section 41. An internal central bore 42 extends through the tubular section 20, the lower portion of the bore 42 being enlarged at 43 to the same dimension as the enlarged bore 31 in the mandrel member 14. The upper end of the enlarged bore in tubular section 20 terminates at a radial shoulder 44, and the lower end of enlarged bore 31 in the mandrel member 14 terminates in a radial shoulder 45. A sleeve 46 of a rigid durable material, which is of an electrically insulating material, is disposed with its opposite ends engaged by the opposed radial shoulders 44 and 45. The diameter of the internal passage 47 in the sleeve is of substantially the same dimension as the bore 30 on the mandrel member 14. O-ring type seals 50 and 51 are disposed in annular grooves formed in the interior surfaces of the enlarged bores 31 and 43 of mandrel member

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and tubular member 20 to ensure a seal between the sleeve and these members. The upper end of the mandrel member 14 and the lower end of the tubular member 20 are each provided with recessed areas which receive a pair of
5 annular seals 52 and 53, which are, of course, of an electrical insulating nature and provide a seal at the upper end of the mandrel member.

Accordingly, the outer housing 13 and the mandrel member are not in direct contact with each other, and the
10 mandrel member 14 is not in direct contact with the tubular member 20 which is made of metal and is in direct contact with the outer housing 13. Any member which is in contact with both the outer housing member 13 and the mandrel member 14 or in contact with both the mandrel member 14 and
15 the tubular member 20 are formed of electrically insulating material.

The inner tapered surface 22 of the outer housing member 13 and outer tapered surface 32 of the mandrel member 14 are separated a distance equal to the thickness
20 of the clearance 33. This clearance, is filled with a bond material which is of an insulating nature and has considerable strength, such as an epoxy. When the shoulder
45 mandrel is held in abutment with the lower end of the sleeve 46, the mandrel member and the outer housing are
25 positioned correctly relative to each other to provide a controlled clearance 33. The bond material, then in a liquid form is injected through an opening 54 in the

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housing member 13, and the material completely fills the clearance and passes down into the spaces adjacent the rods 36. At the upper end the liquid epoxy is retained by seals 50 and 51. The material then sets to provide a rigid bond 5 connection between the tapered surfaces 22 and 32 capable of transferring normally experienced torque forces to between the outer housing member 13 and the mandrel member 14. The bond connection between the tapered surfaces is also capable of transferring forces through the insulation 10 coupler in the longitudinal direction, such as the weight of the portion of the tubular string below the apparatus which places the bonding material in shear and also in compression as the mandrel member 14 is pulled down relative to the housing member 13.

15 In the event of extremely high torsional forces such as in the event of the lower part of the tubular rod becoming jammed, or should the bond material start to fail, torsional forces are transferable from the outer housing member 13 to the mandrel member 14 by way of the rods 36 20 contained in the groove 24 of the housing member and the grooves 35 of the mandrel member. Of considerable importance in the insulation connection is the direction of the slopes of the surfaces 22 and 32 in relation to the connection means provided by the threaded ends of the 25 housing member 13 and the mandrel member 14. In an upward pull of the tubular string from the bore, such as when a lower portion of the string below the insulation coupler is

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becomes jammed, and this pulling force may occur in combination with a torsional exertion, the bonding material in the clearance, while experiencing shear forces is also in a state of compression between the surfaces 22 and 32.

5 Furthermore, in event of failure of the bonding material, the mandrel member cannot disconnect from the housing member as in the longitudinal directions the surfaces can simply move toward an engaging position. Accordingly, the costly situation which occurs when the lower portion of the

10 tubular string becomes separated and lodged in a down-hole location is avoided.

It is apparent that the insulation coupler 11 could be constructed in a manner to be inserted in a tubular string in an inverted orientation and still utilize the basic

15 principle shown in the illustrated embodiment. With obvious modifications, the housing member could be adapted to be connected to the carrier device with the mandrel member, which is electrically isolated from the housing member, being connected to the tubular member above the

20 coupler. The relationship between the tapered surfaces of the two members would still be such that the members could not be separated by an extreme longitudinal pull on the coupler.

At the lower end of the outer housing member 13 there

25 is provided a plurality of screws one of which is shown at 55 threaded into a hole in the outer surface of the housing member. A short groove 56 extends from each screw to the

lower end of the housing member. This provides a terminal connection for an output cable 57 (Fig. 2) extending from the signal transmitter equipment carried by the carrier device 12. Because the outer housing member 13 is

5 insulated from the carrier device and the tubular members carried therebelow, the outer housing and the section in the tubular string thereabove functions as an antenna for the transmitted signals.

As previously described, the lower portion 26 of the
10 mandrel member 14 is attached to an upper end of the carrier device 12 which includes an elongated, generally cylindrical body 57. The body 57 has an outer surface 60 which is of the same outer diameter as the other tubular members of the string, and it is of tubular form having a
15 longitudinal bore 61, which is generally of the same diameter as the bore 30 of the mandrel member 14. The upper end of the bore is enlarged and is provided with internal threads 62 for threaded reception of externally threaded lower portion 26 of the mandrel member 14. The
20 lower end of the enlarged portion of the bore at the upper end of the body 57 provides a shoulder 63 against which the end surface 26 of the mandrel member 13 engages so as to provide a sealed joint. There is further provided an annular groove 58 in the enlarged bore between the threads
25 62 and the shoulder 63, which groove receives a seal 59.

At the very upper end of the body member 57 there is an enlarged bore 64 which is of the same diameter as bore

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25 in the lower end of the housing member 13. While the lowermost end surface of the housing member 13 and the uppermost end surface of the carrier device 12 are spaced, a sleeve 65, which is formed of an electrically insulating material, spans the space and has opposite ends thereof received in the enlarged bores 25 and 64. Within the enlarged bore 25 there is an annular groove 66. Opposite the groove 66, there is provided an annular groove 67 on the exterior surface of the mandrel member 14. The grooves 66 and 67 contain seals 70 and 71 which engage the exterior and interior surfaces, respectively, of the end of the sleeve 65 extending into the enlarged bore 25 of the housing member 13. These seals retain the epoxy at the lower end of the insulating coupler 11, when the bonding material is inserted into the clearance 33. The enlarged bore 64 in the upper end of the body 57 is also provided with an annular groove 72 which receives a seal 73 so as to provide a sealed connection between the insulating sleeve 65 and the body 57.

Defined in the outer surface 60 of the body 57 are a plurality of longitudinally extending grooves or channels 74 which commence a short distance below the upper end of the body 57 and extend substantially to the lower end thereof. The channels 74, which may number four, are circumferentially spaced about the body 57 and are shaped in cross-section to closely receive a sensing instrument or battery pack 75 either of which are designed in the form of

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As can be seen in Figure 1F there is provided at the lowermost end of the cylindrical body 57, a portion 86 of reduced diameter, and near the lower end of the portion 86 there are provided external threads 87. A tubular member 5 92 in the form of a substitute connector is threaded onto the outer end of the portion 86 by way of internal threads 90 in an enlarged bore 91 at the upper end of the tubular member 92. A lower end portion 93 of reduced diameter is externally threaded for reception in an internal threaded 10 portion of adjacent member of the string below the apparatus 10. A bore 94, which is substantially the same diameter as the interior bore 61, extends longitudinally through the tubular member 92. Within the enlarged bore 91 above the internal threads 90 is an annular groove 95 which 15 contains a seal 96.

The portion 86 which is of reduced diameter at the lower end of body 57 extends over the lower ends of the channels 74. A ring member 97 which has an internal diameter only slightly larger than the outer diameter of 20 the portion 86 is positioned between an upper end surface 100 and a shoulder 101 provided at the top of the portion 86. The ring member 97 is free to turn on the reduced portion 86 but there is provided a set screw 102 threaded through the ring and positioned to enter a radial bore 103 25 in the body 57 so as to lock the ring against rotation in a set position when the set screw 102 is turned in. The upper end portion of the ring member has an enlarged

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internal diameter to provide a skirt portion 104 having an internal surface 105. The internal diameter of the internal surface 105 is sufficient that it engages and encompasses the reduced lower ends 77 of the instrument or battery packs 75, thus normally holding the lower parts of such packs snugly within their respective channels 74. The skirt portion 104 of the ring member 97 has a slot, 106 extending into the skirt from an upper edge of the skirt portion, the slot having a width permitting movement of the reduced end portion 77 out through the slot in a direction which is radial relative to the body 57. Accordingly, when the set screw 102 is turned out and the ring member 97 is rotated to locate the slot 106 over a particular channel 74, this lower end of the battery pack or instrument pack located in that channel can be removed. By turning the elongated member 76 of the battery or instrument pack from its respective terminal block the elongated member can be separated from the carrier device, or alternatively by removing the screws 84, the entire unit including the terminal block can be removed.

It can be seen that the carrier device 12 provides a relatively simple and yet rugged structure for mounting in a protected manner the condition sensing means, the power source and the related instrumentation for obtaining and transmitting down-hole information, but which allows ready access of the equipment for replacement and servicing.

The lower end portion 40 of the tubular member or

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an elongated member 76 having an outer or lower end 77 of reduced cross-section (Figures 1F and 2). The upper end of the instrument or battery pack has a threaded male portion which threads into a terminal block 80. Each channel 74
5 has a widened portion 81 at its upper end for receiving a terminal block 80 which is wider than the instrument or battery pack 75. The widened portion 81 further has opposed recesses for receiving opposed ears 83 of the terminal block 80. The ears are provided with holes to
10 receive screws 84 which are threaded into threaded openings in the bottom of recesses 80 as to secure the terminal block and the upper end of the instrument or battery pack which is fastened thereto within the channel 74.

Passages or channels 84 interconnect the widened
15 portions 81 of the channels 74, the channel 84 may receive cables for electrically interconnection of the terminal block. A channel 85 extends longitudinally from at least one of the widened portions 81 of the channel 74 to the upper end of the body 57. The channel 85 can be aligned
20 with the short channel 56 at the bottom of the insulated housing member 13 so that the cable 57 can be accommodated for connection to screw 55 threaded into the housing member 13. The housing member and the tubular section thereabove, which are not insulated from the housing member, as
25 previously described, may function as an antenna for transmitted information from the instrumentation mounted in the carrier device 12.

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section 41 (Figure 1A) is of reduced diameter and is provided with external threads 107 for connection with threads 37 of tubular member 20. The tubular member 41 has an enlarged central bore 108 which extends downwardly a substantial distance from the upper end thereof. The upper portion of the enlarged bore 108 is threaded at 110 for connection to the adjacent tubular section above the apparatus 10. At the bottom of the enlarged central bore 108 there is a bore 111 of smaller diameter which communicates with a bore 112 of larger diameter extending upwardly from the bottom end of lower end portion 41 (Figure 1B). Received in the enlarged bore 108 is a by-pass core member 113 which has a blind central bore 114 positioned to communicate with a central bore of the next adjacent tubular member connected by way of threads 113. The central blind bore 114 communicates with the space exterior of the tubular string in the bore hole by way of radial ports 115. Extending upwardly from the bottom of the core is a blind bore 116 which is in communication with the bore 112 extending to the bottom of the tubular section 41. A supplementary, longitudinal passage 117 communicates with the blind bore 116 and the space adjacent the upper end of blind port 114 whereby fluid pressure within the bore 116 can be evacuated into the well borehole outside of the tubular string.

Extending from the bottom of the tubular member 41 to below the tubular member 92 is a by-pass tube 120, which is

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connected by insulating means to the tubular member 41, and is formed of a material, such as a high strength non conductive plastic. The by-pass tube 120 provides a fluid passageway 121 past the apparatus 10. As shown in Figure 5 1B the upper end of the tube 120 is externally threaded at 122 and is screwed into an insulating collar 123 which may be formed, for example, of Teflon. The lower exterior surface of collar 123 is tapered inwardly. A retainer 124 which has a matching tapered interior bore 125 and exterior 10 threads 126 is turned into interior threads 127 within bore 112 at the bottom of tubular member 41. The collar 123 is received in the retainer and thus fastens the upper end of the tube 120 to the bottom of tubular member 41 and places the passageway 121 in communication within the passage 117. 15 A tubular member of the same structure as 41, which provides a by-pass coupler at the upper end of apparatus 10 may be connected by way of threads 93 of tubular member 92 at the lower end of the apparatus 10 for completing the by-pass connection at that end.

20 The core member 113 within the central bore 110 of the tubular member 41 is also provided with a passageway 130. This passageway communicates at its upper end with the annular space 131 below the end of the tubular member next above tubular member 41, the space 131 being in 25 communication with a fluid source which is controlled for transmitted fluid to controlled components, such as expandible sealing packers. The passageway 130

communicates with the space within the interior bore 42 of the tubular member 20 and outside of the exterior surface of the by-pass tube 120. This space continues to the lower end of the apparatus on the outside of the by-pass tube 5 120, as the interior bores of all of the other components through the apparatus are larger than the outside diameter of the by-pass tube 120. At the bottom of the apparatus communication is made between this space and a passageway (not shown) for separately conducting the fluid to its 10 required location, such as the packer seal.

The by-pass tube is utilized to place the space within the borehole below the apparatus in communication with the borehole above the apparatus. This is done via the central bore of the tubular members deeper in the hole which are in 15 communication with the exterior of the tubular string through the by-pass tube 120 to the tubular member in the string above the apparatus. Accordingly, the build up of a pressure differential, which can force the tubular string upwardly or downwardly, is avoided.

20 While a single embodiment of the invention has been illustrated, modifications within the spirit of the invention as defined in the appending claims, will be apparent to those skilled in the art.

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THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A subsurface signal transmitting apparatus for connection into a tubing string in a bore hole, said apparatus comprising:
an insulation connector assembly.
an instrument carrier device;
said connector assembly including an outer housing member having a first connection means adjacent one end of the connector assembly for attachment to an adjacent tubular section of said string above said connector assembly.
an inner mandrel member having a second connection means for attachment to an upper end of said carrier device, said mandrel member being of tubular form defining a central passageway from said one end to said other end of said connector assembly, and means for electrically insulating said housing member from said mandrel member.
said carrier device including an elongated tubular member having external channels for accommodating instrument sensing units, an internal passageway in said tubular member communicating at an upper end with said passageway in said mandrel member and a lower end of said tubular member, said tubular member having a third connection means at a lower end thereof for attachment of said carrier device to an adjacent section of said string below said carrier device, and

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an electrically insulating by-pass tube extending through said passageways of said mandrel and said carrier device and having fourth and fifth connection means at upper and lower ends thereof, respectively, for connection of opposite ends of said by-pass tube to said sections above and below said apparatus for permitting fluid passage through said apparatus.

2. The apparatus of claim 1, wherein said central passageway in said mandrel and said tubular member forming said carrier device is of greater cross-section than said by-pass tube whereby a space is provided exteriorly of said by-pass tube to form a second fluid passageway.

3. The apparatus of claim 1, wherein said housing member has a bore of large diameter extending downwardly thereinto, said connection means of said housing member including a threaded interior surface of said bore of said housing member, means received within the threaded bore of said housing means and thereby connecting thereinto a tubular by-pass connector, said tubular by-pass connector having a bore therein and port means for placing said bore in communication with said borehole containing said tubular string, means for connecting said insulating by-pass tube thereto, and including means defining a passageway placing said by-pass tube in communication with said bore of said by-pass connector.

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4. The apparatus of claim 1, 2 or 3, wherein said by-pass tube is formed of electrical non-conductive material.
5. The apparatus of claim 3, wherein said means for connecting said by-pass tube to said tubular by-pass connector includes an enlarged threaded bore extending upwardly into said tubular by-pass connector, and means engaging said connections means at the upper end of said by-pass tube for connecting said by-pass tube within said enlarged threaded bore of said tubular by-pass connection.
6. The apparatus of claim 5, wherein said means engaging said connection means at the upper end of said by-pass tube is formed of electrical non-conducting material.
7. The apparatus of claim 3, wherein said housing member has an internal surface portion tapering inwardly away from said bore of said housing member, wherein said mandrel member has an exterior surface portion tapering inwardly from a larger end to a cylindrical portion of smaller diameter, the exterior surface portion of said mandrel member being disposed within the interior surface portion of said housing member and providing therebetween a clearance of substantially constant thickness, and wherein said means electrically insulating said housing member from said mandrel member includes a bond material disposed within said clearance and preventing rotation or longitudinal separation of said members relative to each other.

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8. A connector assembly for connection in a tubing string in a bore hole, said connector assembly electrically insulating an upper section of said string above said connector assembly from a lower section below said connector assembly and comprising:

an outer housing member,

an inner mandrel member,

said housing member having connection means adjacent one end of said connector assembly for attachment of said one end to one of said sections of said string and an internal surface defining an opening tapering outwardly in cross sectional area toward said one end,

said mandrel member having connection means adjacent the other end of said connector assembly for attachment of said other end to the other of said sections, said mandrel member having an exterior surface tapering outwardly in cross sectional area away from said other end of said connector assembly,

said exterior surface of said mandrel member being disposed within said interior surface portion of said housing member and providing a clearance between said surfaces, and an electrically non-conducting bond material disposed within said clearance between said surfaces.

9. A connector assembly as defined in claim 8, wherein said connection means of said housing member includes threaded means for connection of said housing member to a tubular member thereabove, and said connection means of said mandrel

member includes a threaded portion of said mandrel member for connection to a tubular member therebelow.

10. A connector assembly as defined in claim 8, wherein said interior surface of said housing member has a portion thereof including a plurality of circumferentially spaced, longitudinally extending grooves, wherein said exterior surface of said mandrel member has a portion thereof disposed within but radially separated from said portion of said interior surface of said housing member, said portion of said mandrel member having a plurality of circumferentially spaced, longitudinally extending grooves oppositely aligned with said grooves in said portion of said interior surface of said housing member, and including a plurality of rod members each disposed in an oppositely aligned pair of said grooves of said portion of said interior and exterior surfaces.

11. A connector assembly as defined in claim 10, wherein said longitudinally extending grooves are of substantially semi-circular cross-section, and wherein said rod members are of substantially circular cross-section.

12. A connector assembly as defined in claim 10 or 11, wherein said bond material is also disposed amongst said circular rods.

13. A connector assembly as defined in claim 8, wherein said internal surface of said housing member includes an internal

bore of a large diameter at one end of said housing member and an internal bore of a smaller diameter at the opposite end of said housing member, the tapered opening extending longitudinally from said bore of larger diameter to said bore of smaller diameter, and wherein said external surface of said mandrel tapers from a large diameter end portion to a cylindrical end portion defining an exterior surface of smaller diameter, said larger diameter of said surface of said mandrel being of greater diameter than the bore of smaller diameter in said housing member.

14. A connector assembly of claim 13, wherein said connection means of said mandrel member includes said end portion extending downward below said housing member and having thread means for connection to a tubular member therebelow.

15. A connector assembly as defined in claim 13, wherein an interior surface of said bore of smaller diameter has formed therein a plurality of circumferentially spaced, longitudinally extending grooves, wherein an exterior surface of said cylindrical end portion of said mandrel portion has formed therein a plurality of circumferentially spaced, longitudinally extending grooves oppositely aligned with said grooves in said interior surface of said housing member, and including a plurality of rod members each disposed in an oppositely aligned pair of said grooves of said portions of said interior and exterior surfaces.

16. A connector assembly as defined in claim 13, wherein said connection means of said housing member includes thread means within said bore of larger diameter and further includes a first tubular member having a threaded lower end portion for threaded interconnection within said bore of larger diameter, said tubular member including upper thread means for connection to a second tubular member thereabove.

17. A connector assembly as defined in claim 11, wherein said mandrel has a central longitudinal bore extending there-through and an enlarged bore extending downwardly from said larger diameter end portion and terminating at a first radial shoulder, and wherein said first tubular member has a central bore extending therethrough with a lower end portion of said first tubular member being disposed within said housing member, said lower end portion of said first tubular member being provided with an enlarged bore extending upwardly and terminating at a second radial shoulder, and further comprising a sleeve member disposed in the enlarged bores of said mandrel member and said first tubular member, said sleeve member being formed of electrically insulated material and having opposite ends in abutment with said first and second radial shoulders.

18. A carrier device for use in a subsurface signal transmitting apparatus, said device comprising:
an elongated body member having a generally cylindrical outer

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surface,

a first connection means at one end of said body member for attachment of said body member to an insulation connector assembly having an outer housing member electrically insulated from said body member,

said body member having defined in said outer surface a plurality of longitudinal channels commencing adjacent said one end and extending towards an opposite end of said body member,

means for detachably securing instrument sensing units individually within said channels, and

a passage extending from said channels to said one end accommodating a signal transmitting cable extending from said units for electrical attachment to said outer housing of said insulation connector assembly.

19. A carrier device as defined in claim 18, wherein said units include a long tubular portion of a substantially constant thickness terminating in free ends, and a detachable terminal block portion at an upper end thereof, said portions of said units being of slightly less thickness than the depth of the channel in which they are accommodated.

20. A carrier device as defined in claim 18, and further including interconnecting channels between at least some of said longitudinal channels and providing a passage for an electrically transmitting cable extending between said units.

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21. A carrier device as defined in claim 19, wherein said terminal blocks portion have a greater width than said tubular portions, and wherein said channels have widened portions adjacent said one end of said body member for accommodating said terminal block portions.

22. A carrier device as defined in claim 21, wherein said means for detachably securing said units in said channels includes screw means received in openings in said terminal block portions and detachably connected to said body member.

23. A carrier device as defined in claim 19, wherein means for detachably securing said units within said channels includes a ring member encircling said body member adjacent said opposite end, said ring overlying terminal end portions of said channel and said free ends of said tubular sections of said units for holding said free ends within said channels.

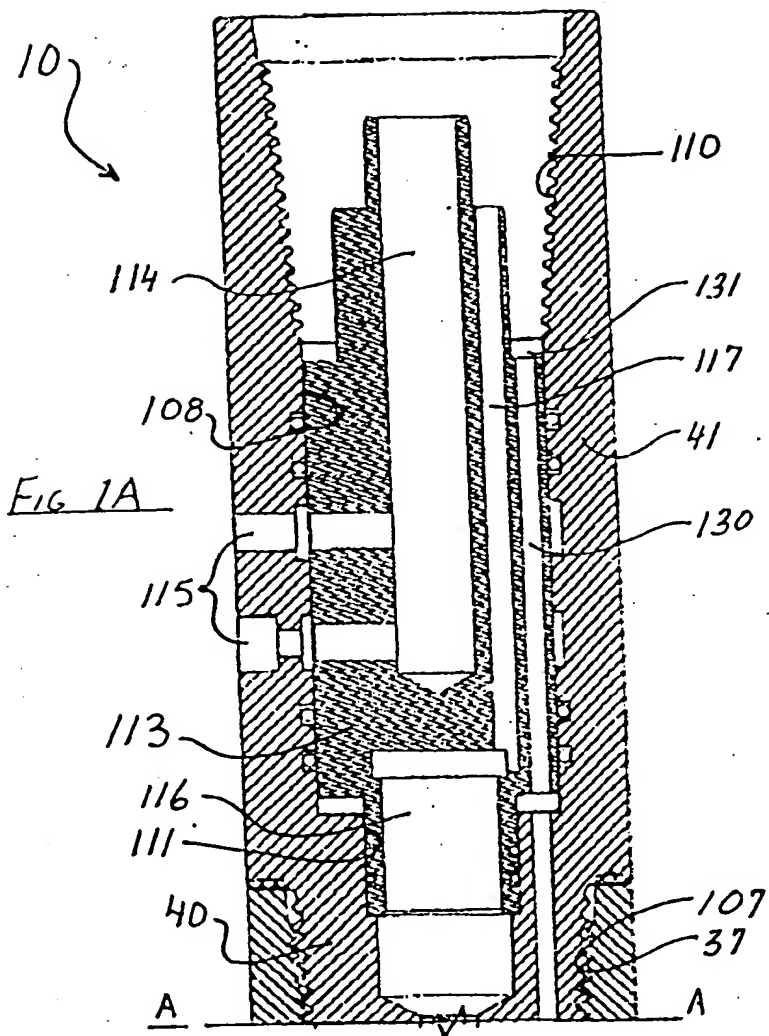
24. A carrier device as defined in claim 23, wherein said ring member is rotatable on said body member, and further includes manually operable lock means for normally preventing the rotation of said ring member.

25. A carrier device as defined in claim 24, wherein said ring member defines a slot therein of a size to permit selected passage of each of the free end portions of one of said units at a time radially outward of its respective

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accommodating channel upon rotation of said ring member to a position in which said slot overlies said accommodating channel.

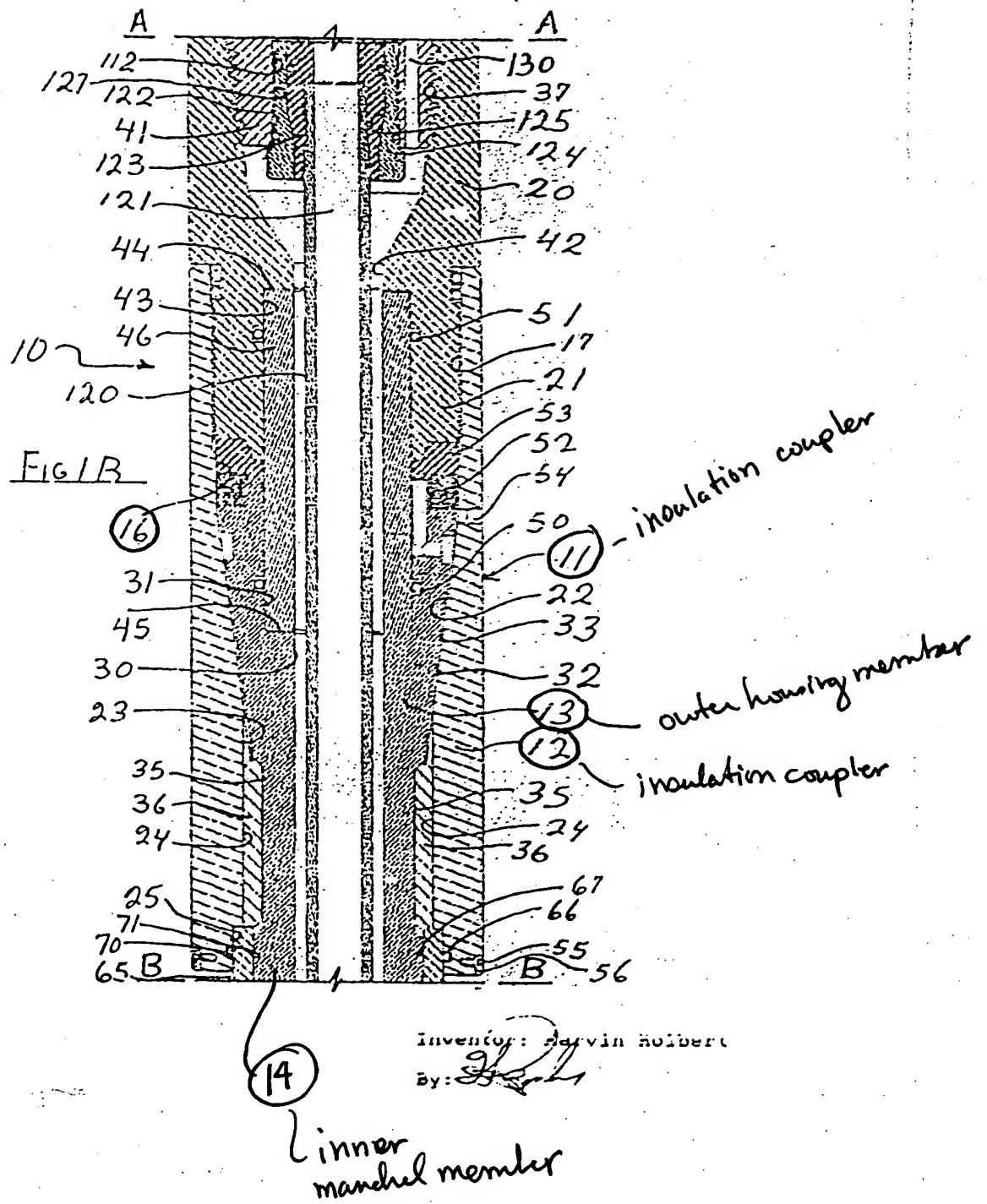
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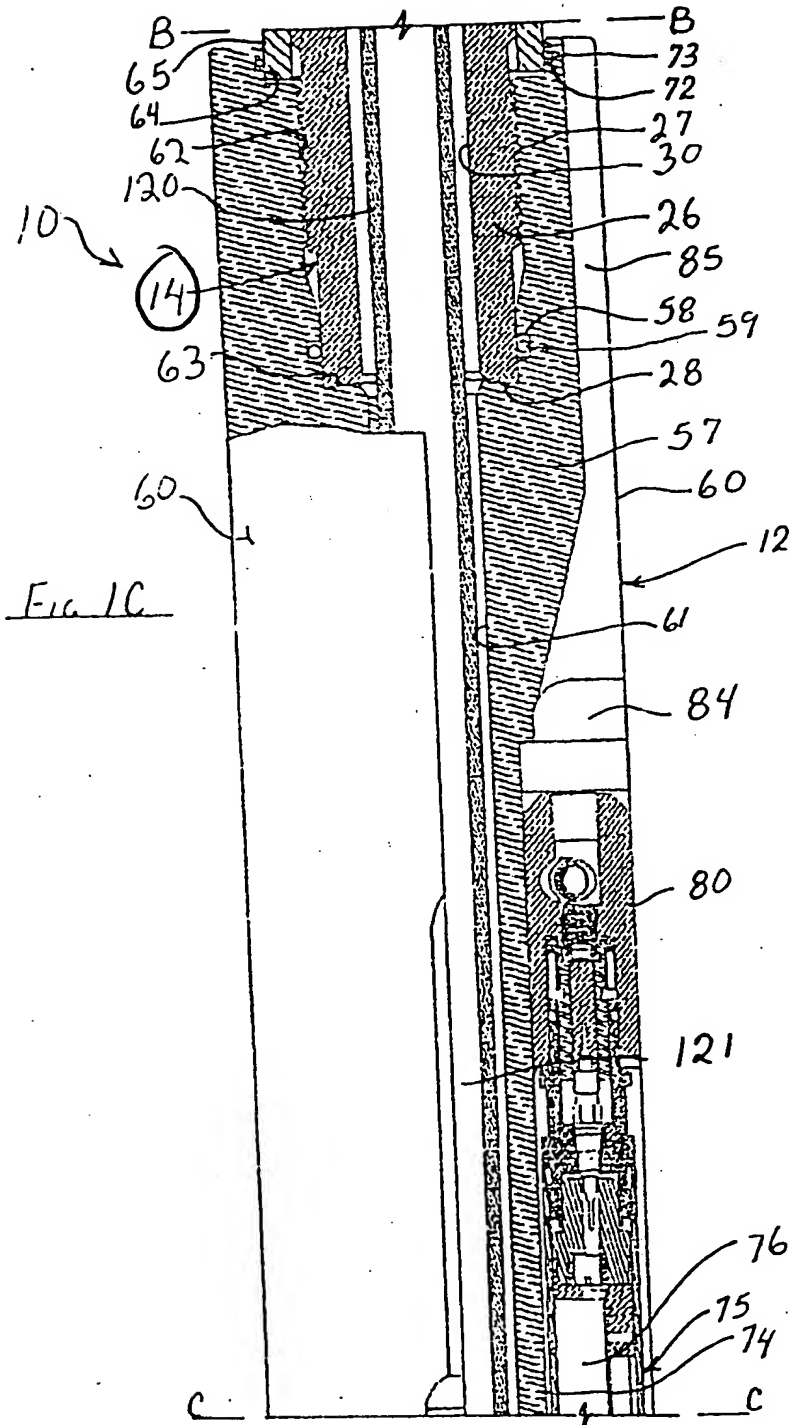
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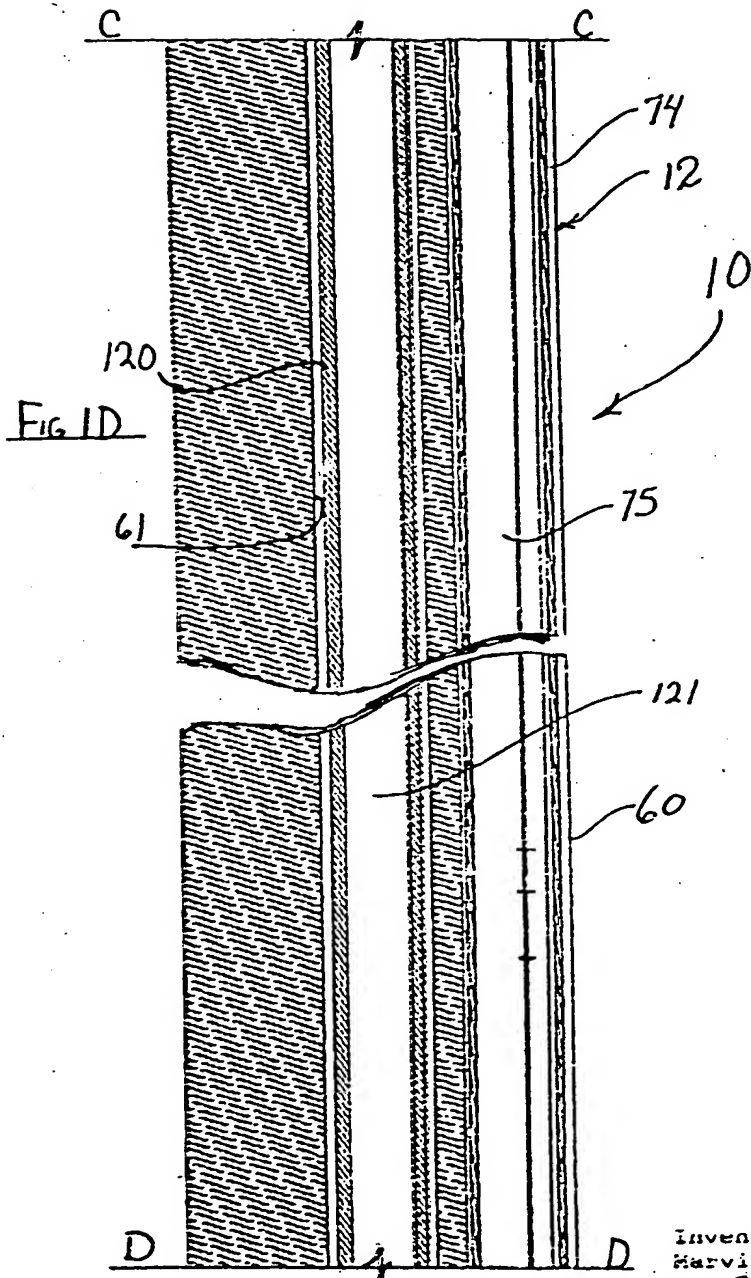


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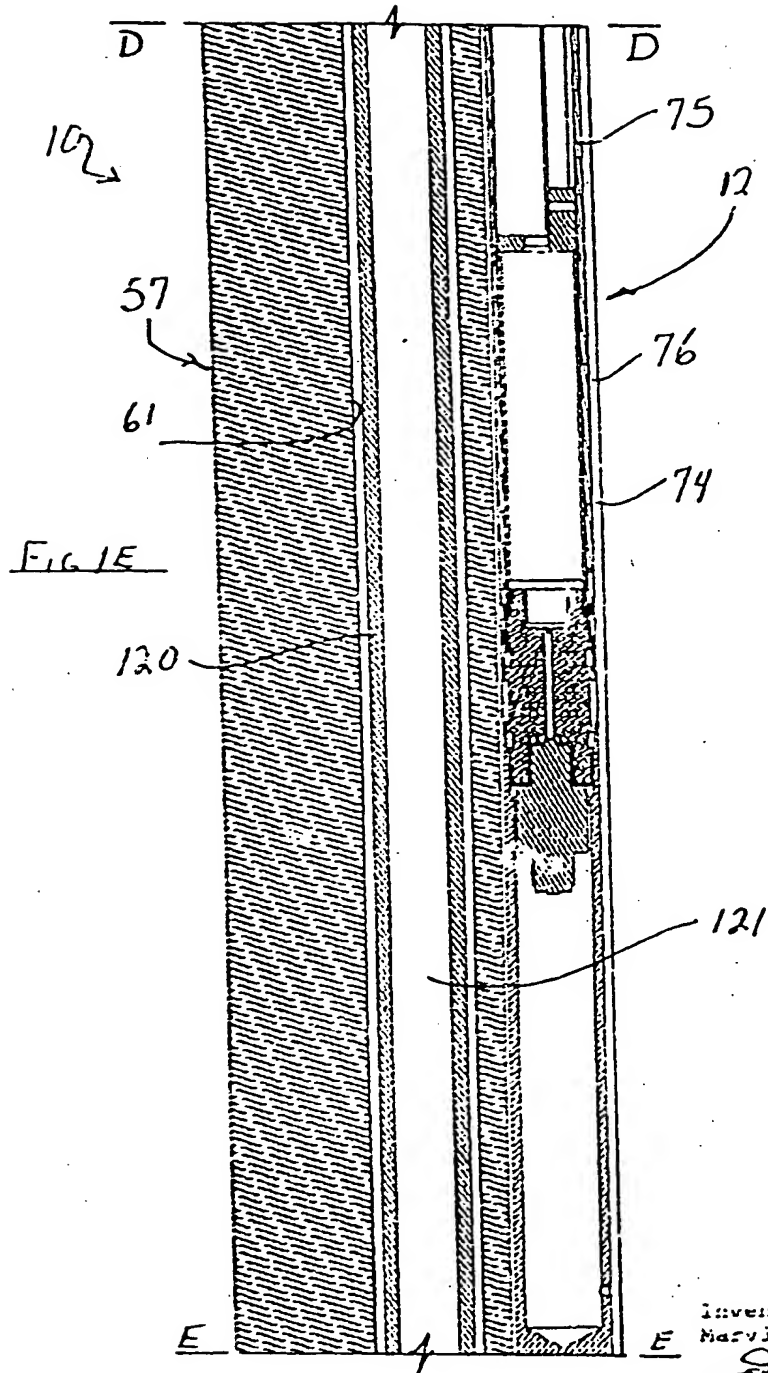
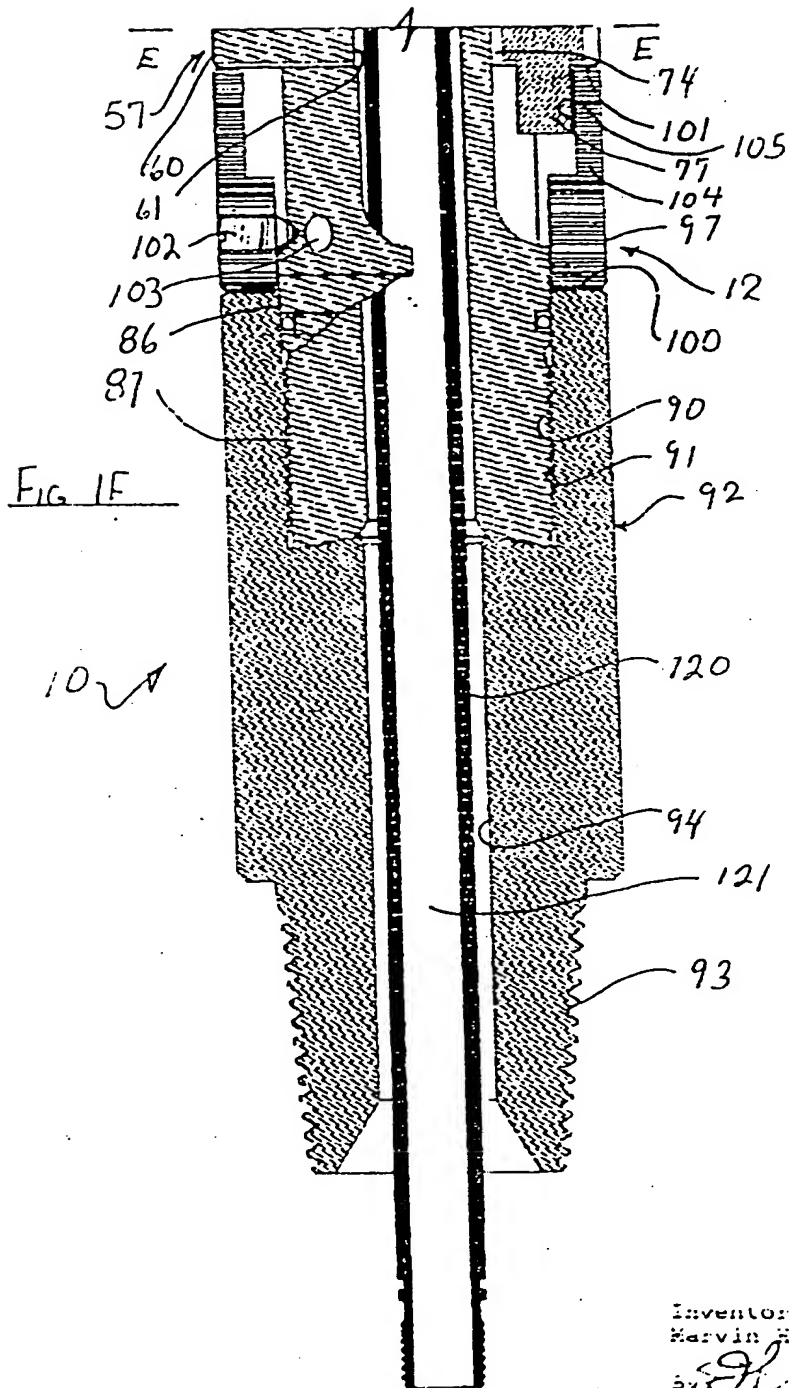


FIG. 1E

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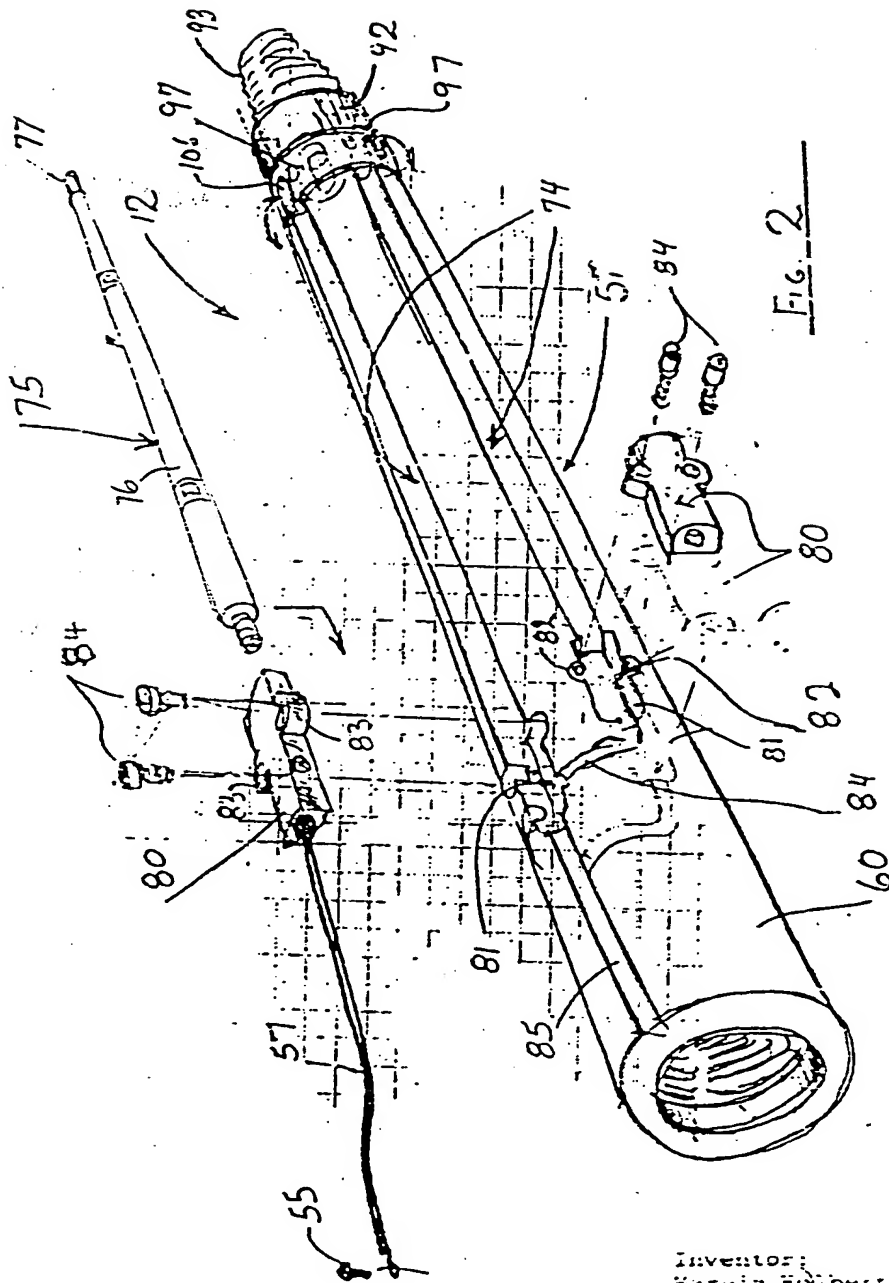


Fig. 2

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